

REMARKS

Responsive to the outstanding Office Action, applicant has carefully studied the Examiner's rejections. The claims pending in this application are claims 10-20. In the response, paragraph [0027] of the specification was again amended and claim 10 was amended for clarity. Claim 21 is newly presented herein. It is respectfully submitted that no new matter was added in this amendment. Favorable reconsideration of the application in light of the following detailed arguments is respectfully requested.

OBJECTIONS AGAINST THE DRAWINGS

The drawings were objected to in that reference numeral 17 was present on figure 2, but was not discussed in the specification, and reference numeral 10 was discussed in the specification but was not shown on figure 2.

The Examiner repeated this rejection from the prior amendment, however it is respectfully submitted that this was addressed in the response to the previous amendment. It is noted, however, that a typographical error was made in the previous amended paragraph. Therefore, paragraph [0027] has been amended again to correct the typographical error entered in the previous amendment.

The specification was amended to remove reference numeral 10 and to substitute reference numeral 17, therefore making the drawings and specification consistent. It is therefore again submitted that no changes to the drawings need to be made in light of this correction.

In light of the above, reconsideration and withdrawal of the objection are respectfully requested.

REJECTION OF CLAIMS UNDER 35 USC §103

In the outstanding Office Action, the Examiner again rejected claims 10-20 under 35 USC §103 as being unpatentable over WO 96/33150 in view of US 5,321,192 to Cottrell. The Examiner states that the WO reference discloses a process for converting alkanes to alkenes comprising contacting the alkane with a dehydrogenation catalyst under conditions sufficient to produce alkene and hydrogen, contacting the effluent with an oxidation catalyst and oxygen, and contacting the effluent with a dehydrogenation catalyst to convert unreacted alkane to additional quantities of alkene and hydrogen. The Examiner acknowledges that the WO reference fails to disclose adding water to the effluent. The Examiner then cites the Cottrell reference to show the use of water in dehydrogenation process. The Examiner states that it would have been obvious to modify the WO process with the water addition of Cottrell.

The US 5,321,192 reference discloses a process of dehydrogenating C2-C5 hydrocarbons in a series of at least two catalytic beds. Prior to the first bed, and after reheating, prior to the second bed 10-300 ppm mol water or equivalent water precursor is injected into the process.

It has been found through use that such a small amount of water precursor introduced to the reaction process has very little effect on the dehydrogenation reaction. The principal benefits of water and water precursors in this context is that water decreases the partial effect of hydrocarbons in the process, thereby allowing higher yield in the dehydrogenation process, and further that water

reduces the coke laydown on the catalyst and therefore allows longer operation time before regeneration of the catalyst beds by coke burn-off.

The above advantages are only noted, however, if water is present in significant extant, i.e. at least 0.5% (500 mol ppm). This is a significant feature of the present invention, the amount of water added through this process, as noted in claim 1, allows the operation of subsequent reaction beds on the same cycle.

With regard to the '192 reference, it should be further noted that the reheating of the effluent from the first reaction zone is performed prior to the addition of water before the second reaction zone. This requires additional equipment and could be detrimental to the process due to cracking reaction occurring after reheating and prior to introduction to the catalyst bed.

In the process of the claimed application, the introduction of water and water vapor cools the reaction temperature thus decreasing the cracking reaction. The heat necessary of the further dehydrogenation is supplied inside the catalyst bed through the selective catalytic reaction of oxygen with hydrogen, thereby preventing non-selective cracking reactions prior to the catalyst bed.

An additional benefit of the claimed process is the possibility of adjusting the steam to hydrocarbon ratio in the second (and potentially subsequent) beds allowing exact control over the amount of oxygen added while at the same time controlling the coke laydown in the second (and subsequent) beds in such a manner that all of the beds operate on the same cycle while avoiding unwanted cracking reactions.

The secondary WO reference applied by the Examiner cannot be combined with the primary reference to render the present claims obvious. One of ordinary skill in the art would not anticipate adding water, as taught by Cottrell as the present invention addresses issues which were not taught or suggested by either of the prior references. The present invention avoids unwanted cracking, controls coke laydown in the catalyst and controls the temperature of the second and subsequent catalyst beds allowing adjustment of the oxygen ratios and with it olefin yields of the second and subsequent beds. Nothing in either of the references suggests this combination, and it is only through the disclosure of the present application that one skilled in the art would be motivated to combine these references as suggested by the Examiner. There is no reasonable explanation, from either of these references, why one skilled in the art would be motivated to use water in the liquid and gaseous phases. The rationale for this is only seen in light of the disclosure of the present invention.

In view of the above, it is respectfully submitted that independent claim 11 distinguishes over the applied art of record. Claims 11-20, which depend directly or indirectly from independent claim 11, are believed to be allowable based, at least, upon this dependence. Newly presented claim 21, is similar to claim 11, but further explicitly discloses that the introduction of steam and liquid water cools the hydrocarbon to prevent premature cracking reactions. It is believed to also be allowable over the art of record.

SUMMARY

It is believed that the above amendments place the application in condition for allowance. Should the Examiner wish to modify the application in any way, applicant's attorney suggests a telephone interview in order to expedite the prosecution of the application.

Respectfully submitted,

A handwritten signature in black ink, appearing to read 'Mark A. Hixon', with a stylized flourish at the end.

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